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6. RI SUMMARY

This chapter summarizes the RI portions of the RI/FS document. The primary aim of the chapter is to highlight key RI findings and conclusions in order to serve as an introduction to the FS, and to focus the FS on the most important aspects of the site physical setting, ARARs, and extent of chemical constituents in environmental media.

6.1 Site Background

The Landsburg Mine site consists of a former underground coal mine located approximately 1.5 miles northwest of Ravensdale in southeast King County, Washington. The site is located directly south and east of the S.E. Summit-Landsburg Road and north of the Kent-Kangley Road. The Cedar River passes within approximately 500 ft of the site to the north. The location of the site in the Seattle, Washington area is shown in Figure 1-1. Figures 1-2 and 1-3 depict the immediate site vicinity.

The mine site occupies property owned by Palmer Coking Coal Company (PCC) and Plum Creek Timber Company, L.P. and is located within sections 24 and 25, Township 22 N., Range 6 E. A defined Study Area for the site, prescribed by Ecology for the purposes of this RI/FS, is depicted in Figures 1-2 and 1-3. Property boundaries for the site are shown in Figure 1-4.

PCC operated an underground coal mine known as the Landsburg Mine from the late 1940s until approximately 1975. The Rogers Seam, one of three seams mined at the site, was mined from 1959 until 1975. The mined section of the seam has a near vertical dip and consists of coal and interbedded shale approximately 16 ft wide. The mined section is about a mile in length. Mining occurred at depths of up to 750 feet using a mining method locally termed "booming" which followed the coal seam vertically. As a result of underground mining of the Rogers Seam, a subsidence trench developed on the land surface above the mine workings. The dimensions of the trench vary, from about 60 to 100 feet wide, between 20 to 60 feet in depth and about 3/4 mile in length.

A portion of the trench was used in the late 1960s to the late 1970s for disposal of various industrial wastes, construction materials, and land-clearing debris. Drums, liquid from tanker trucks and other industrial materials were disposed of in the northern portion of the trench. Disposal of land clearing debris continued until the early 1980s. Currently, the site is secured by a fence and locked gate which encloses the northern portion of the trench where disposal occurred.

Several preliminary environmental investigations have been performed at the site, including a limited soil gas survey (Applied Geotechnology 1990), sampling of area private wells (WDOH 1992), and sampling surface water emanating from mine portals (Geraghty and Miller 1990). No hazardous substances above naturally-occurring background levels were detected in any of these investigations.

Due to continued concerns over potential environmental hazards posed by the Mine, however, Ecology commissioned a Site Hazard Assessment (SHA) study in 1991. Ecology then requested potentially liable parties (PLPs) to perform an expedited response action (ERA) which resulted in the removal of over 100 55-gallon drums from the trench. These investigations did detect hazardous substances, including volatile and semi-volatile organic compounds, PCBs, cyanide and metals, in drum contents, adjacent soils and ponded surface water within the northern portion of the trench where prior waste disposal is believed to have occurred.

On the basis of these results, Ecology and the PLPs entered into an Agreed Order (WDOE 1993a) in July 1993 which directed the Landsburg PLP Group to conduct an RI/FS to evaluate human and environmental health risks posed by the site and develop appropriate remedial alternatives. The data collected under the RI are considered adequate to characterize site conditions and support evaluation and selection of a preferred remedial alternative in the FS. A summary of the RI is presented below.

6.2 RI Data Collection Activities

The Work Plan (Golder 1992a) and support project plans together with the *Conceptual Model of the Landsburg Mine Site* (Golder 1992b) provided the necessary rationale and details for implementation of the RI/FS. Data collection activities conducted under the RI included the following tasks:

- **Task 3 - Air Monitoring.** Three air monitoring surveys were conducted along the subsidence trench bottom in the northern half of the mine within the fenced and secured former disposal areas to monitor for the presence of volatile organic compounds.
- **Task 4 - Facility Environmental Assessment (Level 1).** A Level I Environmental Assessment (EA) was completed to identify historical land uses, ownership, and previous activities that may have resulted in the generation, storage or disposal of hazardous materials at the site.
- **Task 5 - Private Well Survey.** A well survey was conducted to identify private and public wells within the Study Area, and to support the selection of wells for quarterly sampling.
- **Task 6 - Surface Water Sampling and Flow Monitoring From Portals #2 and #3.** Surface water associated with Rogers mine portals #2 and #3 was sampled for chemical analysis over four rounds of quarterly sampling. The flow rate of water emanating from portal #3 was measured on a weekly basis.
- **Task 7 - Surface Soil Sampling.** Surface soils around the trench rim perimeter and downslope of portal #3 were sampled for chemical analysis.
- **Task 8 - Source Characterization in Rogers Trench (Geophysical Investigation).** A magnetometer survey was conducted along the centerline of the Rogers Seam

trench to identify areas of potential buried waste. Additional EM/magnetometer and GPR surveys were conducted at both ends of the Landsburg Mine to determine monitoring well placement.

- **Task 9 - Monitoring Well Drilling and Installation.** Seven new monitoring wells (LMW-1 through -7) were installed at the site. Wells LMW-2/4 and LMW-3/5 consisted of nested well pairs installed within the coal at each end of the trench at the points of expected mine groundwater discharge. LMW-1 was installed overtop a suspected location of a fault and tunnel connecting offset portions of the Rogers Seam. Wells LMW-6 and -7 were installed in the Frasier and Landsburg seams, respectively, to provide indications of water quality typical of adjacent coal seams. Angled drilling methods were used at the LMW-4 and LMW-7 well locations to intercept the coal seam. Cores of the coal seam were obtained from LMW-2, -3 and -5. Slug tests were conducted in selected wells to determine hydraulic properties. The wells were equipped with dedicated sampling systems to facilitate periodic sampling.
- **Task 10 - Groundwater Sampling and Analysis.** Fourteen selected private wells and the newly installed groundwater monitoring wells were sampled over four quarterly sampling rounds. The samples were submitted for a broad range of chemical analyses including metals and cyanide, volatile and semi-volatile organics, pesticides and PCBs, and general chemical parameters. Private well sampling during round 4 was conducted at a reduced number of wells.
- **Task 11 - Topographic Survey and Geodetic Control.** Using aerial photogrammetry techniques, a topographic base map of the site was prepared to 2 ft contours. Horizontal control was established based on the Washington State Plane Coordinate System as required under MTCA.
- **Task 12 - Ecological and Social Data.** Relevant ecological and social data were obtained for the site and Study Area, including information on meteorologic and surface water characteristics, land use (zoning) and water use at the Study Area, endangered species, priority habitats, and sensitive areas. This information was obtained largely from readily available sources.
- **Task 13 - Geologic Reconnaissance.** Geologic reconnaissance activities consisted of limited geologic mapping to confirm the understanding of surficial geology presented in the Conceptual Model, and the excavation of backhoe test pits to examine subsurface lithology in the immediate vicinity of the Rogers Seam.

All environmental sampling activities were conducted under an approved Quality Assurance Project Plan (QAPP) which was included as part of the Work Plan (Golder 1992a). Most field and data collection activities were completed during the period from October, 1993 to May, 1995.

6.3 Site Physical Conditions

6.3.1 General

Apart from the former Mine operations, the only development in the Study Area is residential with approximately 90 residences contained within the Study Area. A dirt road accesses the property and trails run parallel to the east and west sides of the trench (Figure 3-1). The access road begins near S.E. Summit-Landsburg Road and follows along the northern portion of the trench. A locked gate secures the site at the access road entrance, and the portion of the trench where disposal occurred is currently enclosed by an 8 ft tall chain link security fence. Dense vegetation covers the site. The Mine property sits atop a gently sloping hill which reaches a maximum elevation of approximately 800 ft mean sea level (MSL) near the central portion of the site. At the site's northern end (Figure 3-1), this hill slopes steeply downwards towards the S.E. Summit-Landsburg Rd. (elevation of approximately 615 ft) and continuing to the Cedar River (elevation approximately 500 ft). The southern portion of the site slopes more gradually downwards to the south toward the Kent-Kangley Rd. and Rock Creek drainage located at an elevation of approximately 600 ft. The site is bounded to the east by a somewhat larger hill which rises to a maximum elevation of approximately 940 ft.

Electrical transmission lines and a Bonneville Power Administration property easement cross the southern portion of the site in an east-west direction. Approximately 3/4 mile upstream of the northern portion of the site along the Cedar River at Landsburg, the City of Seattle Water Department maintains a drinking water supply intake known as the Landsburg Diversion which serves as a major source of water for the Seattle area. Water is conveyed from the intake through a 96-in diameter pipeline to the Lake Youngs Reservoir. The pipeline passes just to the north of the site and is located at the toe of the slope between the S.E. Summit-Landsburg Rd. and the Cedar River. A meteorologic data collection and river gaging station, operated by the City of Seattle, are located at the water intake structure.

6.3.2 Source Characteristics

Beginning in 1969, a portion of the trench was used for the disposal of various waste materials, including industrial wastes, construction and land-clearing debris, tires and miscellaneous household garbage. Materials were disposed into the mine trench from the site access road indicated in Figure 3-1. Hazardous materials were dumped until 1978. Dumping of other materials continued intermittently until about 1983. Industrial wastes were contained in drums or dumped directly from tanker trucks. Based on invoice records from Palmer Coking Coal Company, an estimated 4,500 drums and about 200,000 gallons of oily waste water and sludges were disposed into the trench. Available documented interviews with waste haulers indicate that some of the drums contained wastes including paint wastes, solvents, metal sludges and oily water and sludge (WDOE 1990).

The approach taken during the RI was to focus environmental sampling efforts on potential pathways of chemicals leaving the mine, and not on wastes present within the mine itself. Therefore, what is known regarding the contents of the mine is based on visual reconnaissance, records searches, and geophysical surveys. On the basis of these sources of information, previous waste disposal and any potential remaining wastes appear to be confined to the northern half of the trench in three sections separated by pillar walls. Pillar walls are areas where subsidence has not occurred. These three sections are shown in Figures 3-4 and 3-6. In these sections, fill areas are present along much of the trench floor and sidewalls. These fill areas resulted from past disposal activities, which usually included covering the waste periodically with soil. Native soil generally was bulldozed over the trench edge to cover the waste material. Magnetic anomalies, which are indicative of buried ferrous metallic objects, which may include drums, were detected in these three sections. The thickness of introduced fill, potential waste materials and naturally eroded soils present within the trench is unknown. The nature of any remaining waste materials is uncertain beyond that which is known regarding what was disposed in the trench. Given that up to 4,500 drums were reportedly placed in the trench and approximately 100 were recovered during the ERA, it is reasonable to expect that wastes potentially remaining include a significant number of drums buried beneath the trench bottom surface at some depth. It is important to note, however, that based on the condition of the drums observed in the ERA, the length of burial, physical damage during placement, reported fires, etc., the vast majority of drums have ruptured, deteriorated or been destroyed.

6.3.3 Geology

Site stratigraphy consists of a thick sequence of folded Tertiary bedrock of the Puget Group mantled by glacial drift of the Vashon (and possibly Pre-Vashon) glacial stage. The glacial drift materials at the site are comprised primarily of till and recessional outwash. The till consists of a compact mixture of gravel in a clayey, silty sand matrix. Recessional outwash is comprised of a well-sorted mixture of sand and gravel. Till mantles the hillsides and recessional outwash generally fills in the lowlands. The total thickness of the glacial deposits ranges from near 0 near the hilltops to possibly in excess of 100 ft in the lowland areas and stream channels. In most areas of the site itself, the thickness of the drift is probably between about 10 to 50 ft.

The Puget Group is composed of non-marine sandstones and siltstones with numerous carbonaceous shale and coal beds and minor amounts of claystone and conglomerate. All gradations between sandstone and siltstone are present, and most of the rocks are either silty sandstone or sandy siltstone. These materials are typically fine-grained, and except for the coal which is typically very weak and friable, are generally well-cemented and strong. The thickness of the Puget Group rocks at the site is not known but is probably at least several thousand ft.

A typical east-west section through the Rogers Seam is shown in Figure 3-13. On the east side of the seam is a massive sandstone bed and one foot thick layer of shale. The coal seam itself is approximately ten ft in thickness. On the west side is a four to seven ft thick carbonaceous shale, and a massive sandstone (Eltz 1992). The thickness of individual beds varies from a few ft to tens of ft.

The bedrock in the Study Area vicinity has been extensively folded into a series of north and northeast-trending folds (Gower and Wanek 1963). Most of these structures are south-plunging asymmetric folds with east-dipping axial planes. The site and Study Area are situated over the western limb of a northeast trending anticline. Puget Group strata dip steeply with dip angles of the Rogers coal seam and adjacent strata near 90° on the north end of the site and 63° at the south end of the mine (Figure 3-14).

The rocks in the Study Area have been displaced by numerous faults (Figure 3-9). Most noteworthy is the fault in the northern portion of the mine where approximately 75 feet of displacement (PCC 1992) required a 130 ft long rock tunnel to reconnect mining operations to the coal seam. This was the only mapped fault which resulted in complete loss of the coal seam. The fault extends vertically through all four levels of the Rogers Mine to land surface where the unmined and hence uncollapsed rock pillar is used for the trench cross-over roadway. This fault also appears to have been encountered when mining the Landsburg seam some 750 ft east of the Rogers Seam (Falk 1992); the location of this contact indicates that the fault strikes approximately east-west. Water inflows into the mine from this fault were not noted by mine personnel. Review of mine records found no evidence of fault gouge.

Pertinent features of the smaller faults include; offsets of from 2 to 16 ft (Mine Superintendent's Drawings); polished surfaces (Eltz 1992); and tightness (reports by all interviewed personnel that mining through fault zones did not result in increased water flow). The Puget Sound - Olympic Peninsula province is characterized with the major principal horizontal stress being a north-south compression. Faults that are steeply dipping with east-west strikes should therefore be tight due to the north-south compression.

6.3.4 Mine History and Condition

6.3.4.1 History

The Rogers Seam was mined from four (4) different levels accessed from three (3) slopes/declines as shown on Figures 3-2 and 3-9; a "water level" tunnel was also constructed to facilitate water removal from the upper level. The seam was mined from 1959 until 1975 when all active mine openings were closed by blasting. During this time frame, approximately 490,000 tons of clean coal were produced.

Two other underground mines were also operated in seams adjacent to the property (see Figure 3-2). The Frasier seam, located to the west of the Rogers Seam, was mined intermittently from the late 1800s to the mid 1940s. The Landsburg seam, located to the east of the Rogers Seam, was worked intermittently from the 1930s to about 1977.

6.3.4.2 Mining Methods

Due to the vertical orientation of the coal seam, the Rogers mines utilized a system of coal extraction involving the development of "levels" with coal extracted by "booming" between underlying and overlying levels. This mining term, simply refers to the process of blasting pillars of coal isolated between adjacent crosscuts/entries and chutes. The booming round (see Figure 3-13) was initially fired in the uppermost pillar to start the cave. Coal was then "pulled/drawn" through the first open chute and loaded into mine cars.

Groundwater control was accomplished by grading the gangway at a slight incline with positive drainage back towards the bottom of the mine access slope. Water gravity drained, via a shallow ditch dug in the footwall, to a small sump at the slope bottom and was pumped, from there, out of the mine. It is difficult to precisely estimate the quantity of water entering and pumped from the Rogers mine(s), however, an approximate range in inflow rates is possible based on mine personnel estimates, back-analysis of water accumulations observed during power outages, and pump capacity/utilization. The most likely value for pumping is about 35 gpm with a minimum expected value of 20 gpm, and a maximum value of 80 gpm.

6.3.4.3 Mine Stability

Trench Bottom. Slabbing failure of the sandstone footwall has been reported by mine personnel. As coal was drawn down during mining operations, areas of the sandstone sidewall were observed to "slide" into the trench bottom. It is believed that these slabs could mask underlying voids. Voids may also remain at great depth due to the incomplete collapse of the workings, however, because of their greater depth these voids are of lower concern with regard to trench bottom stability. Using an approximate method of analysis, the overall volume of remaining voids was estimated to be less than 10%. Although it is likely that a majority of trench bottom subsidence has already occurred, it is prudent to allow for further subsidence when evaluating and designing any remedial measures.

Trench Sidewall. The mapped sequence of strata forming the trench sidewall included interbedded sandstone, shale, and siltstone; no evidence of sidewall instability was observed. However, slabbing failure, similar to that observed by retired PCC personnel, may occur if material is removed from the trench bottom or if further subsidence occurs.

Potential for Waste Movement After Dumping. A majority of the drummed waste was deposited in the trench north of the rock bridge (major fault in northern part of mine). The last mining beneath this area was completed at the end of 1967 approximately one year prior to waste deposition. Fourth level mining beneath the trench immediately to the south of the rock bridge began in September of 1970 and was completed in 1974. While there was some potential for movement of the contained waste after deposition north of the rock bridge, it is considered unlikely that significant deformations occurred. There is a modestly higher probability that waste in the trench to the south of the rock bridge has settled since deposition. Settlement of the waste could result in debris moving down into the mine.

6.3.5 Meteorology and Surface Water

6.3.5.1 Surface Water

The major surface water features at the Study Area are the Cedar River along the Study Area's northern boundary and Rock Creek within the southern boundary. Rock Creek represents the only perennial creek or stream within the Study Area boundaries. Rock Creek ultimately drains into the Cedar River approximately 2 miles downstream of the site. Figure 3-16 depicts the primary surface water flow pattern and features of the Study Area.

The mine site itself has only ephemeral drainages which discharge during prolonged or intense periods of rainfall. The southern portion of the mine site drains towards Rock Creek and the northern half drains to the Cedar River.

The lower elevations around the perimeter of the Study Area are covered by relatively permeable outwash sands and gravels at the land surface. Rainfall is expected to readily infiltrate these materials. The elevated portions of the site either have surface outcrops of bedrock or a thin veneer of glacial drift (till) which will inhibit infiltration relative to the permeable outwash deposits. In general, surface water flow at the site is expected to run-off the hills, collect in ephemeral drainages and flow to the lower elevations where it infiltrates into the outwash deposits or flows into Rock Creek or the Cedar River. Some run-off also flows into the mine trench, depending on the local topography and drainage patterns. Run-off flowing into the mine trench collects in several ephemeral pools where it infiltrates or evaporates.

Water occurrence at portals #2 and #3 is perennial and is expected to represent natural groundwater discharge. Another pool, the so-called "sludge pond" located just to the north of well LMW-1, is also perennial but not an expression of groundwater. The water present at portal #2 occurs as a pool which is completely retained and enclosed as a shallow depression. Mine portal #3 occurs as seepage where water emanates along a sloping seepage face, flows along the ground surface for a short distance, and gradually re-infiltrates back into surficial soils.

6.3.5.2 Meteorological Characteristics

The average precipitation at the site ranges from slightly less than 1.5 inches in July to nearly 8 inches in December. In general, the months of July through September are driest, and October through January are the wettest. Yearly precipitation averages 56.52 inches with a maximum of 76.39 and a minimum of 32.93 inches. On average, January is the coldest month and August the warmest with average daily low temperatures ranging from 37° to 49° and average daily maximum temperatures ranging from 51° to 85°.

6.3.6 Hydrogeology

The primary hydrogeologic system at the site consists of a continuous to semi-continuous groundwater system comprised of the Puget Group bedrock materials and the surrounding glacial outwash aquifer. Minor occurrences of groundwater in till overlying the bedrock are likely perched and of secondary importance. The bedrock materials, which make up the hills within the Study Area, protrude up through and discharge to the glacial outwash which fills the surrounding valleys and lower elevations around the perimeter of the Study Area.

The mined/backfilled Rogers coal seam is a highly permeable conduit with hydraulic conductivities on the order of about 1 to 5 cm/s. The two portions of the trench separated by the fault near LMW-1 are in good hydraulic communication with each other, and the mine may be thought of as forming one relatively continuous, highly conductive zone. The fine-grained sediments located to either side of the seam are at least several orders of magnitude less permeable than the mined out seam. Faults through the coal seam are probably tight and do not act as significant conduits, based on the regional state of stress, mine reports, water level measurements, and geochemical analyses. Vertical gradients, and therefore vertical flow, also appear to be small within the coal seam. Therefore, groundwater flow in the trench primarily occurs horizontally and along strike through the highly permeable mined out Rogers Seam. Flow laterally away from the Mine (across bedding or via faults) is considered negligible. The trench can therefore be thought of as a highly conductive "slot" or "pipe". Groundwater within this "slot" moves longitudinally with very little movement laterally away from the trench. Wells installed in Puget Group materials and located laterally away from the mine are hydraulically isolated from the mine workings. There is no observable pathway for chemicals to migrate from the mine to these wells. These include wells LMW-6 and -7, and private wells PW-5 through -8, and PW-14 and -15.

Mine reports, geochemical data and the rapid response of groundwater levels to seasonal rainfall patterns suggests that recharge of the coal seam is primarily by direct rainfall infiltration. The trench effectively collects and concentrates rainfall and runoff from the surrounding area. This runoff readily infiltrates through the porous structure of the mined out seam and recharges the local water table.

Due to the preference for longitudinal flow within the trench and site topography, and as evidenced by the discharge observed at portals #2 and 3, discharge from the mine occurs at either end. A groundwater divide is therefore present within the trench. To the north of this divide, flow is to the north, and to the south of the divide, flow is to the south. There is some uncertainty with respect to the location of this divide, however, based on the high conductivity of the trench, topography and presence of ponded water in the southern portion of the trench, the divide is believed to occur within the southern third of the Mine. The majority of flow from the mine and in particular for that portion of the trench utilized for waste disposal is therefore to the north.

Mass balance considerations, flow measurements made at portal #3, and the reports of mine dewatering have indicated that the total flow rate of water entering as infiltration and exiting near the portals is on the order of about 10 to 20 gpm.

6.3.7 Ecologic and Social Characteristics

6.3.7.1 Land Use (Zoning)

The bulk of the Study Area, including much of the central portion of the site and the former mine workings, has been assigned an RA, Rural Area Zone classification. The western portion of the Study Area from the coal mine areas to Summit-Landsburg Road, has been designated F for forest use. In addition to these zoning classifications, the City of Kent and City of Seattle maintain municipal watershed lands along the western and eastern boundaries of the Study Area, respectively, for the protection of drinking water supplies associated with Rock Creek and the Cedar River. Also, under the Shoreline Management Plan of King County, the Cedar River shoreline throughout the Study Area vicinity has been designated a "Conservancy" environment. The site zoning is shown on Figure 3-25.

6.3.7.2 Water Use

Surface Water. The City of Seattle has operated a large water diversion structure upstream of the Mine site at Landsburg since 1901. The structure diverts approximately 150 million gallons per day (mgd) from the Cedar River. An infiltration gallery adjacent to Rock Creek has been used by the City of Kent since the early 1900s for use as a municipal water source. The existing diversion, referred to as the Clark Springs facility, consists of a lateral gravity drainage collection system installed approximately 13 to 15 ft below ground surface in the creek alluvium. This facility was sampled as part of this RI and was referred to as well PW-13.

Groundwater. A survey of private wells in the area, summarized in Table 2-1, identified a total of 56 wells within the Study Area. Excluding the Clark Springs facility which serves the City of Kent, these wells serve approximately 91 homes at the Study Area and 236 people. The wells range in depth from less than twenty feet to a maximum depth of about 400 feet. Many of the shallow wells were hand dug and range between 20 and 30 feet in depth.

6.3.7.3 Endangered Species

The USFWS identified the bald eagle as the only listed endangered species sighted near the Study Area. Bald eagles may winter within this area from approximately October through March. Several candidate species were also identified by the USFWS as potentially occurring in the Study Area. These include the bull trout, mountain quail, northern goshawk, northern red-legged frog, northwestern pond turtle, pacific fisher, and the spotted frog. The USFWS did not identify any proposed species in the Study Area vicinity.

6.3.7.4 Priority Habitats and Species

Wetlands. Mapped wetlands occur in two areas within the Study Area. These are shown in Figure 3-26. The first of these consists of an area identified by the Washington Department of Wildlife (WDW) in the northern trench area. While field reconnaissance by GAI personnel did identify a number of wet areas within the trench, the area identified by the WDW was never observed to contain water during this RI. The second area occurs just inside the southern site boundary and is shown on the King County sensitive areas maps, as discussed below.

Other potential wetland areas, not shown on any governmental maps, were identified by GAI field reconnaissance. These include minor wet areas within the trench as well as other areas of ponded water located in the Study Area. Figure 3-26 depicts the potential wetland areas identified by GAI. Final determination of the status of these areas as wetlands will require a site visit by a qualified biologist or ecologist and will be performed during subsequent remedial planning tasks.

Habitats. The WDW has mapped the Cedar River along the northern Study Area boundary as a critical spawning habitat for resident species. This portion of the river has also been identified as an anadromous fish run and as having resident species present. Rock Creek is not identified as a critical fish habitat by the WDW; however, it is considered a high-quality salmonid habitat and a 2.5 mile stretch of Rock Creek has been designated a Regionally Significant Resource Area by the Cedar River Watershed Management Committee (King County Dept. of Public Works 1993).

Species. The WDW indicates that bald eagles are a priority species and have used areas near Black Diamond as a breeding area. There are no documented sitings in the Study Area, however.

The WDW Non-Game Heritage Data System documents point observations of nongame species of concern in the area by reputable sources. While observation for several species occur in the vicinity of the Study Area, there are no documented observations in the Study Area itself. In addition, there is no documented spotted owl activity within the Study Area.

6.3.7.5 Sensitive Areas

Sensitive areas as defined by the King County Sensitive Areas Ordinance (Ordinance 9614) include wetlands, areas prone to stream and flood hazards, erosion hazards, seismic hazards, and coal mine hazards. Development of land within identified sensitive areas requires special development standards as well as special studies to assess impacts and to propose adequate mitigation, maintenance, monitoring and contingency plans for those areas. Identified sensitive areas are shown in Figure 3-26.

As discussed above in Section 6.3.7.4, there is one small wetland area within the southern site boundary identified in the King County Sensitive Areas map. This area is located over 1,000 ft from the trench.

Streams are considered sensitive areas because of their esthetic values, their ability to provide recreation, support wildlife, and potentials for flooding and erosion. The Cedar River is identified as a Class I stream for its length from Landsburg to Renton. This indicates the river is inventoried as a Shoreline of the State under the King County Management Plan. Rock Creek to the south of the site is classified as a Class II stream that flows year-round during years of normal rainfall and is used by salmonids. Rock Creek is ephemeral to the east of where it crosses beneath the Kent-Kangley Road.

Two large areas of the site are described as susceptible to erosion. The first is the steep northern slope along the Cedar River. The second is the steep hillside in the eastern portion of the Study Area between the trench and Study Area boundary.

There are no landslide hazard areas identified for the site or identified seismic hazard areas.

The portions of the Landsburg Mine site where coal removal occurred are mapped as coal mine hazard areas.

6.4 ARARs

This section briefly summarizes information presented in Chapter 4 focusing on the most significant potential applicable or relevant and appropriate requirements (ARARs) for the Landsburg Mine site. The full list of potential ARARs is presented and discussed in Tables 4-1 and 4-2. Potential specific regulatory limits (cleanup standards) for groundwater, surface water, and soil are presented in Tables 4-3, 4-4, and 4-5, respectively. The primary potential ARARs for the site include the following:

- Model Toxics Control Act (MTCA), RCW 70.105D, and MTCA Cleanup Regulations, WAC 173-340; and
- Minimum Functional Standards for Solid Waste Handling, WAC 174-304.

In addition, portions of the dangerous waste regulations (WAC 173-303) may be relevant and appropriate. These are discussed briefly below.

Model Toxics Control Act (MTCA), RCW 70.105D, and MTCA Cleanup Regulations, WAC 173-340. MTCA is the key governmental regulation governing the conduct of the overall investigation and cleanup process for the site and is therefore applicable. MTCA describes the requirements for selecting cleanup actions, preferred technologies, policies for use of permanent solutions, the time frame for cleanup, and the process for making decisions.

Specific criteria for the various cleanup methods are presented in the MTCA regulations. Generally, technologies that recycle or re-use materials are preferred most, followed by methods that destroy or detoxify hazardous substances, and cleanup methods that may leave contaminants on-site. Although MTCA identifies a hierarchy of preferred technologies that should be evaluated for use in the cleanup action, cost may also be a factor in determining points of compliance and selection of cleanup actions.

Recent amendments to MTCA (RCW 70.105D.090) exempt remedial actions conducted pursuant to an Agreed Order or a Consent Decree from the procedural requirements of several state laws. These include the State Clean Air Act (RCW 70.94), Solid Waste Management - Reduction and Recycling Act (RCW 70.95), Hazardous Waste Management Act (RCW 70.105), Water Pollution Control Law (RCW 90.48), Shoreline Management Act (RCW 90.58), and Construction Projects in State Waters (RCW 75.20). In addition, the exemption also applies to the procedural requirements of any laws requiring or authorizing local governmental permits or approval for the remedial action. Therefore, while substantive compliance is necessary, permits and approvals are not required for remedial actions at the site.

WAC 173-340-700 establishes cleanup levels for environmental media, including groundwater, soil, surface water and also contains standards for air emissions. Three methods are presented for determining cleanup levels: Method A (routine, using tables), Method B (standard), and Method C (conditional, primarily for industrial sites). Method A is generally used for routine cleanups with relatively few contaminants. Method B is the standard method for determining cleanup levels and assumes a residential use scenario. Method C cleanup levels are used in circumstances where Method A or B are not appropriate, as specified in WAC 173-340-706. Methods B and C levels are determined using federal or state ARARs or are based on risk-based equations specified in MTCA regulations. All three MTCA methods for determining cleanup levels require compliance with other federal or state ARARs, and consideration of cross-media contamination. For groundwater cleanup criteria, the regulations specifically identify federal Maximum Contaminant Levels (MCLs), Secondary Maximum Contaminant Levels (SMCLs), and non-carcinogen Maximum Contaminant Level Goals as applicable.

Dangerous Waste Regulations - WAC 173-303. The Washington State Dangerous Waste Regulations (WAC 173-303) are the state equivalent of the federal hazardous waste (RCRA) regulations, and contain a series of rules relating to the generation, handling, storage and disposal of “dangerous waste.” Recent MTCA amendments, as discussed above, exempt cleanup actions conducted under an Agreed Order or Consent Decree from the procedural requirements of these regulations. In addition, a recent amendment to the state Hazardous Waste Management Act (RCW 70.105) provides a conditional exemption to state-only dangerous wastes generated when a remedial action is conducted pursuant to a Consent Decree with Ecology. The exemption is not applicable to material that is a hazardous waste under RCRA.

Therefore, no WAC 173-303 procedural requirements will be applicable to remedial actions conducted at the site if the actions are conducted pursuant to a Consent Decree or Agreed Order. WAC 173-303 substantive requirements pertaining to dangerous waste generation, handling, storage, and disposal may be applicable, however if non-exempt dangerous waste is generated and/or transported off the site unit boundary during cleanup.

Closure and post-closure standards in the dangerous waste regulations are To Be Considered (TBC). Some of these standards (WAC 173-303-610, -645, and -665) are relevant to the Landsburg Mine site. Portions of these regulations may be appropriate, and therefore ARAR.

Minimum Functional Standards (MFS) for Solid Waste Handling - WAC 173-304-407 and -460 describe closure and post-closure standards and landfill standards, respectively. Under, MTCA, MFS the “minimum requirements” for landfill closure conducted as a MTCA cleanup action. On this basis, the MFS are applicable to this site. WAC 173-340-460 capping requirements include a minimum 2 ft. thick soil layer having a permeability of 1×10^{-6} or lower. Alternately, a synthetic liner material may be substituted for the soil layer. The MFS standards are the primary capping criteria to consider in this FS.

6.5 Nature And Extent Of Chemical Constituents

The air, soil, groundwater, and surface water analytical data collected as part of the RI, as well as other data collected during the preliminary investigations (the SHA and ERA), were evaluated in this RI to assess the nature and extent of chemical constituents in environmental media at the

Landsburg Mine site. The primary purpose of this evaluation was to identify the chemical compounds potentially posing a human or environmental health risk and/or which exceed potential regulatory criteria, and which are the result of the prior waste disposal activities. Such compounds are termed the Contaminants of Concern (COC). In order to accomplish this, the data were evaluated through a step-wise screening process which considered laboratory and field blank data, background concentrations (if available) and appropriate regulatory criteria (ARARs).

On the basis of the data screening performed, the following conclusions were drawn:

Air. Throughout nearly all of the trench, volatile organic compounds were not detected at all in air. Detectable levels of volatile organic compounds in air were very low and restricted to only a small area within the trench in the vicinity of the sludge pond. Air monitoring conducted during drilling did not detect significant levels of volatile organic compounds.

Groundwater. The results of groundwater sampling indicate that no federal drinking water standards (Maximum Contaminant Levels) are being exceeded at the Mine site itself or amongst any of the private wells sampled in the Study Area. The State of Washington MTCA Method B standard for arsenic ($5\text{ }\mu\text{g/L}$) was exceeded at three private wells (levels up to $19\text{ }\mu\text{g/L}$) and the MTCA Method B standard for manganese ($80\text{ }\mu\text{g/L}$) was exceeded at 5 monitoring wells (levels up to $299\text{ }\mu\text{g/L}$) and 3 private wells (levels up to $416\text{ }\mu\text{g/L}$).

Secondary Maximum Contaminant Levels, which are not health based standards but are intended to be protective of aesthetic water qualities only, were exceeded for aluminum, iron, manganese, total dissolved solids and pH at a number of wells located throughout the Study Area, including both private wells and monitoring wells. SMCLs were exceeded at every monitoring well. Of the 14 private wells sampled, seven of the wells had at least one exceedance of a SMCL over the four rounds of sampling. Iron is the most prevalent compound exceeding an SMCL.

Although a few organic compounds were detected in wells sampled, all of the detects were very low and inconsistent (not repeated in more than a single round). In addition, none of the organic compounds exceeded any established regulatory standards, except for one instance of bis(2-ethylhexyl)phthalate, a common laboratory contaminant, which occurred slightly above the MTCA Method B standard in round 2 in a private well, but was not detected in either of the other three rounds. There is therefore no indication of organics contamination in groundwater at the Study Area.

The observed distribution of chemical constituents in groundwater around the Study Area indicate that waste disposal activities at the Mine are not the source of these compounds. Maximum levels of some compounds occur in wells which are hydraulically isolated from the Mine with no apparent pathway for chemical migration. Also, the levels observed at the Mine are consistent with reports in the literature which indicate that coal is a natural and well-known source for these chemical constituents. The levels observed fall within the range of reported values considered typical for coal-mine drainages in the State. Therefore, while SMCLs are exceeded for several compounds and a MTCA Method B cleanup level is exceeded for two compounds, the occurrence of these compounds is not related to prior waste disposal activities

at the Mine, but rather to natural background levels typical of coal-bearing strata. There are therefore no Contaminants of Concern for groundwater at the Landsburg Mine site.

Surface Water. Arsenic exceeded a MTCA Method B standard for surface water at portal #2 and #3. The levels of arsenic observed are consistent with groundwater levels measured at the mine site. As discussed above, the occurrence of the compound in groundwater (and therefore surface water) is a result of natural background conditions. There are therefore no Contaminants of Concern for surface water at the site.

Soil. There are no identified contaminants of concern for soils outside of the trench. Within the trench, chromium, lead, PCBs, bis-(2-ethylhexyl)phthalate, methylene chloride, TCE and TPH exceed Method B standards in an area confined to the northern portion of the trench where waste disposal is thought to have occurred in the past. Soil contamination was not noted outside this area. These compounds are designated as COCs for soil inside the trench. On the basis of trench sampling conducted to date, however, and in conjunction with historical information and geophysics, potential contamination is believed to be restricted to the northern portion of the trench.

Therefore, apart from soils located within the subsidence trench in the area of known prior waste disposal activities, soil, groundwater and surface water media in the Study Area do not exhibit concentrations of chemical constituents above naturally occurring background levels. The only COCs identified in this RI are the 6 compounds indicated above for soils inside the trench.

6.6 Conceptual Model of Waste Fate and Migration

6.6.1 Prior Materials Discharged to Trench

As discussed above in Section 6.5, the RI data collection and evaluation activities have resulted in the conclusion that no chemical constituents are migrating off of the site in surface water or groundwater above naturally-occurring background levels. Chemicals are present above background and regulatory limits only in soils within the trench itself, and these occurrences are confined to the areas of known waste disposal. Other than these occurrences in soil, there are no observed measurable impacts within or outside of the Study Area from prior waste disposal activities.

These conclusions have been arrived at in spite of the reported disposal of significant volumes of waste at the site. It is therefore appropriate at this point to discuss the potential mechanisms or factors which may have resulted in the observed distribution (or lack thereof) of site chemicals, and specifically on the reasons why chemicals are not being detected off-site. There are four mechanisms proposed below that may explain, either singly or in combination, the apparent lack of chemical residues in groundwater and surface water leaving the mine site. There is uncertainty as to the cause, however, and the actual explanation probably represents a combination of factors. The best explanation that can be offered at this time is that the great majority of the liquid wastes disposed to the mine (in drums and as free liquids from trucks) was consumed in the fires and/or has already been discharged from the trench due to the very

permeable nature of the trench materials and deterioration which typically occurs with drums. Some constituents were sorbed onto the coal or soil and remain immobilized. Much of the wastes were relatively inert or innocuous. A minor number of drums may be still intact and contain liquids. Solid wastes may also still be present in intact and damaged drums. A combination of four mechanisms probably occurred.

1. Wastes disposed in the trench are no longer present, either because they were consumed in the fires known to have occurred or have already discharged through the highly permeable mined out Rogers Seam.
2. The residual coal remaining in the mine, with its high sorptive capacity, has immobilized the wastes in-place.
3. Some of the drums were either empty when dumped or filled with relatively inert or innocuous substances. Much of the 200,000 gallons of oily wastewater would have had very low concentrations of chemicals.
4. Wastes are contained within intact drums and have not yet been released.

Mechanism 1. As discussed in Section 3.2.1, a series of major fires are known to have occurred in the trench during 1972. Most of the flammable materials present in the trench at that time was probably consumed. Also, as was shown in Section 3.6.3.3 (Hydraulic Properties), the mined out Rogers Seam is highly conductive and has the potential to transmit large quantities of water. Movement through the unsaturated zone would be very rapid also since the material present above the water table consists of loose, mined out debris which is essentially similar to the material present below the water table. Liquids discharged to the trench therefore would move rapidly downward to the water table where they would then travel quickly downgradient and exit from the mine. Since disposal was in the northern portion of the trench, liquids would have discharged to the northeast once they reached the water table. Discharge from the seam would have been to the glacial outwash deposits bordering the site and ultimately to the Cedar River and Puget Sound. However, given the lack of contamination observed in the fine-grained, carbonaceous deposits associated with the mine, the chance that chemicals have been retained within the coarse-grained fluvial deposits of the Cedar River is considered extremely unlikely.

Mechanism 2. Adsorption is where soluble substances are removed from solution by binding to the surface of a solid. Activated-carbon treatment of wastewater is a standard treatment technology to remove dissolved organic matter. Coal is commonly used in the production of activated carbon because it has a high sorptive capacity. The mine probably offered a significant capacity to adsorb (and absorb) organic contaminants due to the presence of coal and the large amount of surface area which was likely available for such interactions. Some quantity of the wastes discharged to the mine have been bound in a sorbed phase onto the coal surfaces.

Mechanism 3. It is not known whether the approximately 4,500 drums disposed in the trench were full, partially full, or empty. Likewise, it is not known what substances were contained in the drums. While many drums presumably contained flammable liquids (as evidenced by the fires), it is possible that a significant percentage of the drums were only partially full or empty.

Likewise, it is possible that many of the drums contained inert materials. The same may be true of the oily wastewaters.

Mechanism 4. The results of the geophysical survey performed along the centerline of the Rogers Seam identified areas where ferrous materials are potentially buried beneath the trench floor. Records suggest that up to 4,500 drums were originally placed in the mine while about 100 were removed during the ERA. There is a high likelihood, therefore, that a large number of drums still remain in the trench at some depth below the trench bottom. Some of these drums may still be intact. The chance that the observed lack of contamination at the site is due to the wastes being contained within the drums is considered to be low, however. Mutch and Sutherland (1990), in a study estimating the life of landfilled drums, reported that corrosive pitting begins to compromise drum integrity within about two to nine years after landfilling, depending on pH and soil aeration. In case studies of drum life in landfills, drums began to leak within a few years of their deposition as a result of corrosive pitting. In addition, observations suggest a significant percentage of drums undergo immediate disruption and leakage as a result of rough handling, compaction, or intentional puncturing during landfilling. Therefore, while some wastes are probably still present within drums, most of the drums ruptured during placement, or have rusted and/or deteriorated over the years. Most of the drums removed during the ERA were severely deteriorated. Much of the liquid wastes contained within the drums has therefore been released. Any liquids released from drums would have moved rapidly through the trench, as with mechanism 1 above. In addition, 200,000 gallons of free liquids were reportedly discharged from trucks and were not subject to any containment. There is still the potential, however, that a limited quantity of liquid and solid waste may still be present within the trench in intact or partially intact drums.

6.6.2 Current Condition

The primary mode of potential chemical migration from the mine consists of the groundwater pathway. Geophysical data and historical information presented in this RI have indicated that potential waste may be buried beneath the bottom of the trench and is generally confined to the northern half of the site. Given that groundwater flow beneath this portion of the site is to the north and flow laterally away from the mine is considered to be negligible, the primary pathway of chemicals potentially exiting the mine is to the north. Future groundwater monitoring activities should therefore focus on detecting potential releases at the northern end. The chance that such a discharge could occur at the southern end is considered unlikely given the direction of groundwater flow and the apparent absence of waste in this portion of the Mine.

Once exiting the site, potential chemical constituents leaving the northern portion of the mine will flow primarily to the north and northeast towards the Cedar River, consistent with the local ground surface topography. Discharge to the river would occur at a point approximately one mile downstream of the City of Seattle's water intake at Landsburg. This flow will occur within the Rogers coal seam, which presumably extends downslope towards the river, and within the glacial outwash materials which overlie the coal. Figure 3-19 depicts the piezometric surface contours of the site groundwater system. Figure 3-24 depicts the primary pathway of potential mine chemicals exiting the site. As seen in the figure, there are no drinking water wells located along the primary pathway of groundwater flow.

While the primary flow direction is towards the river, it is also possible that flow could occur to the northwest within the glacial outwash to the north of the mine. If groundwater flows in this direction, potential receptor points would include wells PW-4 and PW-3 and the other private wells located along the Summit-Landsburg Rd (Figure 3-19). Well PW-4 is the closest well and is approximately 1,500 ft away from the trench. It is not considered likely, however, that groundwater flow would occur to these wells given the strong topographic gradient towards the river.

At the southern end of the mine, potential receptors include the cluster of wells along the Kent-Kangley Rd. just southwest of portal #3, and the Clark Springs facility. The series of wells near portal #3 are within about 300 ft of the portal. The Clark Springs facility is approximately 2,500 ft from the portal. It is not considered likely that these wells would ever be impacted.